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Penetrating Atherosclerotic Aortic Ulcer: Documentation by Transesophageal Echocardiography

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Objectives. **This study sought to describe the ability of transesophageal echocardiography (TEE) to document the presence of penetrating atherosclerotic aortic ulcers and their complications.**

Background. **TEE has greatly enhanced our ability to assess patients with suspected aortic disease. However, the utility of this technique in the diagnosis of penetrating atherosclerotic aortic ulcers is still undefined.**

Methods. **TEE was performed prospectively in 194 patients to evaluate aortic disease. Twelve patients with the diagnosis of aortic ulcers or their complications were specifically studied. The diagnosis was confirmed by pathologic studies in six patients and by an additional diagnostic technique (angiography, computed tomography or magnetic resonance imaging) in the other six. All 12 patients were hypertensive and presented with chest or back pain; the mean age was 65 years (range 56 to 79). The initial working diagnosis was acute aortic dissection in nine patients. Aortic ulcers were located in the descending thoracic aorta in eight patients, the aortic arch in two and the ascending aorta in two.**

Results. **TEE could detect aortic ulcers or their complications in 10 patients but failed to detect these lesions in the remaining 2 (1 with aortic ulcers in the distal ascending aorta and 1 with aortic ulcers in the aortic arch). In four patients, aortic ulcers were detected as a calcified focal outpouching of the aortic wall and were associated with concomitant aneurysmal dilation of the aorta in two patients and with a small localized intramural hematoma in one. TEE visualized a partially thrombosed pseudoaneurysm complicating an aortic ulcer in the descending thoracic aorta of two patients. Four patients had an aortic ulcer complicated by a "limited aortic dissection" in the descending aorta that could be detected by TEE. Five patients underwent operation, two because of aneurysmal dilation of the aorta and three because of aortic dissection; two patients died of aortic rupture; the remaining five did well (11-month follow-up) without operation.**

Conclusions. **Aortic ulcers should be included in the differential diagnosis of chest or back pain, especially in elderly hypertensive patients. These ulcers and their complications may be recognized by TEE.**

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The term "penetrating atherosclerotic aortic ulcer" describes the condition in which ulceration of an aortic atherosclerotic lesion penetrates the internal elastic lamina into the media (1). This lesion may precipitate intramural hemorrhage and is associated with a variable amount of intramural hematoma formation, aneurysmal dilation, pseudoaneurysm or aortic rupture (1). Thus, it is important that the presence of a penetrating atherosclerotic aortic ulcer be recognized. Transesophageal echocardiography (TEE) has greatly enhanced our ability to assess patients with suspected aortic disease. However, the utility of this technique in the diagnosis of penetrating atherosclerotic aortic ulcers is still undefined. The present report sought to describe the ability of TEE to document the presence of penetrating aortic ulcers and their complications.

Methods

Patients. The study included 12 men who underwent TEE and were diagnosed as having a penetrating aortic ulcer or its complications. Most patients required additional tests to confirm the diagnosis. The 12 patients were part of a group of 194 consecutive patients who were prospectively studied by TEE to evaluate aortic disease and were seen at one of three hospitals between 1995 and 1997. TEE findings in the 182 patients with no aortic ulcers were intramural aortic hematoma or classical aortic dissection (n = 93), aortic aneurysm (n = 18), coarctation (n = 4) and normal aorta (n = 67). Some patients underwent other diagnostic tests as well. The clinical characteristics of the 12 study patients are presented in Table 1. The

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Abbreviations and Acronyms

CT = computed tomography (tomographic)
MRI = magnetic resonance imaging
TEE = transesophageal echocardiography (echocardiographic)

patients were 56 to 79 years old (mean age 65) and had a long history of hypertension and a widened mediastinal silhouette on the chest X-ray film. Ten patients were smokers, seven had hyperlipidemia, and six had coronary artery disease. Ten of the 12 patients presented with chest or back pain, and the initial working diagnosis was acute aortic dissection in nine. In 2 of these 10 patients chest pain was accompanied by syncope. Four patients were first categorized as having nonclassic aortic dissection, which was classified as a complication of an aortic ulcer after pathologic correlation in three or confirmation by magnetic resonance imaging (MRI) in one. Finally, two patients (Patients 3 and 11) were admitted to the hospital because of an acute coronary syndrome and underwent TEE to document concomitant dilation of the aorta.

The diagnosis of aortic ulcers was confirmed by histologic studies in six patients and by an additional diagnostic technique (angiography, computed tomography [CT] or MRI) in the other six. In one patient, autopsy study was not authorized.

Echocardiography. Echocardiographic examinations were performed using commercially available 5-MHz biplane and multiplane transesophageal transducers and Toshiba SSH 160A and 140A imaging systems. The TEE examination was performed in the intensive care unit or the echocardiography laboratory. Patients received mild intravenous sedation (1 to 2 mg of diazepam and 25 to 50 mg of meperidine), and continuous blood pressure and electrocardiographic monitoring was performed. Patients were examined in the left lateral decubitus position. Conventional transverse and longitudinal sections of the ascending aorta, aortic arch and descending thoracic aorta were obtained. The distal part of the ascending aorta could not routinely be visualized because of interposition of the left bronchus. The examination technique has been described in detail elsewhere (2,3). For every patient, gain and instrument settings were established to optimize imaging of the arterial wall. Images were recorded on videotape for subsequent analysis and interpretation.

Penetrating atherosclerotic aortic ulcer was defined as a craterlike outpouching in the aortic wall, with jagged edges generally associated with extensive aortic atheroma (Fig. 1). Aortic wall thickening with inward displacement of intimal calcification was an indication of associated intramural hematoma. In the early stages, before clotting, intramural hematoma may be echolucent (4) (Fig. 2). The lumen surface of the aorta was evaluated for the presence of thrombotic material.

Aortography, CT scanning and MRI criteria. *Aortic ulceration* by aortography, CT and MRI was defined as a localized contrast-filled outpouching of the aortic wall. Thickening of the aortic wall external to sites of intimal calcification detected by CT or localized areas of high signal intensity in the aortic wall on T1-weighted images were consistent with localized intramural hemorrhage (5,6).

The existence of diffuse aortic enlargement, localized narrow-neck aortic dilation (pseudoaneurysm), an intimomedial flap or a through and through aortic rupture was also investigated by all techniques.

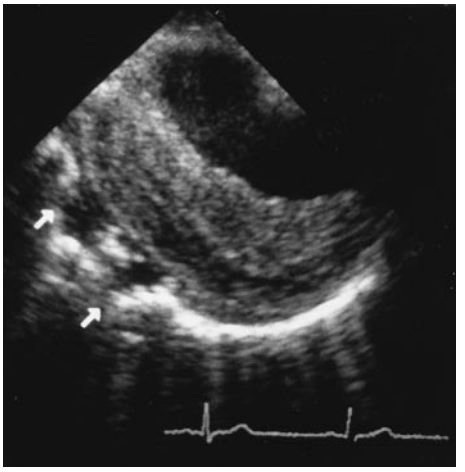


Figure 1. Patient 1. TEE scan showing penetrating aortic ulcers (**arrows**) in the descending thoracic aorta.

Figure 2. Patient 1. TEE scan (**top**) and corresponding anatomic specimen (**bottom**) showing intramural aortic hematoma (**asterisks**) in the descending thoracic aorta. TR = thrombus.

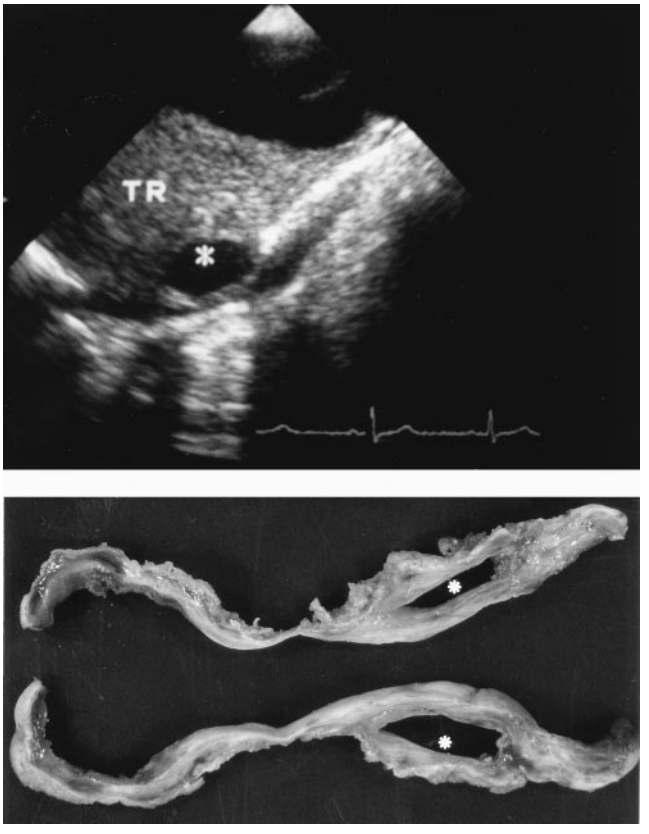


Table 1. Demographic and Clinical Data for 12 Study Patients

Pt No.	Gender/ Age (yr)	CAD	PAU Site	Symptoms at presentation	TEE Findings	Confirmation	Angiographic Findings	Operation	Outcome/ Follow-Up
1	M/67	No	Descending thoracic Ao	1-yr Hx of intermittent and progressive back pain on effort	Descending Ao aneurysm with thrombus; 2 PAUs within aneurysm; echolucent AIH	Anatomy, MRI, CT	Descending Ao; aneurysm; PAU not seen	Yes	Alive/2 yr
2	M/61	No	Ao arch	Acute chest and back pain	Ao arch aneurysm; PAU within aneurysm	Anatomy, MRI	PAU in Ao arch	Yes	Alive/1.5 yr
3	M/65	Yes	Descending thoracic Ao	Unstable angina	PSA (narrow-neck Ao dilation) partially filled with thrombus in descending Ao	MRI	Not done	No	Alive/2 yr
4	M/72	Yes	Ao arch	Acute chest pain	PAU not seen by TEE	CT	PAU in Ao arch	No	Died/24 h (Ao rupture)
5	M/56	Yes	Distal ascending Ao	Acute chest pain	PAU not seen by TEE	Anatomy	Not done	No	Died/4 days (Ao rupture)
6	M/73	Yes	Descending thoracic Ao	1-yr Hx of back pain	"Localized dissection" in descending Ao (thick, calcified flap)	Anatomy, MRI, CT	Dissection seen	Yes	Died/1 yr (MI)
7	M/79	No	Ao arch	Chest pain	PSA (narrow-neck Ao dilation) partially filled with thrombus in descending Ao	MRI, CT	PSA seen	No	Alive/1 yr
8	M/59	No	Descending thoracic Ao	Acute chest and back pain	"Localized dissection" in descending Ao (thick, calcified flap; entrance and reentrance tears)	Anatomy, CT	Not done	Yes	Alive/1 yr
9	M/68	Yes	Descending thoracic Ao	Acute chest and back pain	"Localized dissection" in descending Ao (calcified, nonoscillating flap)	Anatomy, CT, MRI	Dissection seen	Yes	Alive/1 yr
10	M/56	No	Descending thoracic Ao	Chronic back pain	Dilated descending thoracic Ao; PAU in descending thoracic Ao; mural thrombus; calcified, mobile atherosclerotic plaques	MRI	Not done	No	Alive/14 mo
11	M/64	Yes	Ascending Ao	MI	PAU in ascending Ao (craterlike outpouching with calcified edges)	MRI	Not done	No	Alive/6 mo
12	M/70	No	Descending thoracic Ao	Acute chest and back pain	Dilated descending thoracic Ao with mural thrombus; PAU in descending thoracic Ao; "localized dissection" in descending Ao with clotted false lumen (calcified, thick flap)	MRI, CT	Not done	No	Alive/3 mo

AIH = aortic intramural hematoma; Ao = aorta, aortic; CAD = coronary artery disease; CT = computed tomography; F = female; Hx = history; M = male; MI = myocardial infarction; MRI = magnetic resonance imaging; PAU = penetrating aortic ulcer; PSA = pseudoaneurysm; TEE = transesophageal echocardiography (echocardiographic).

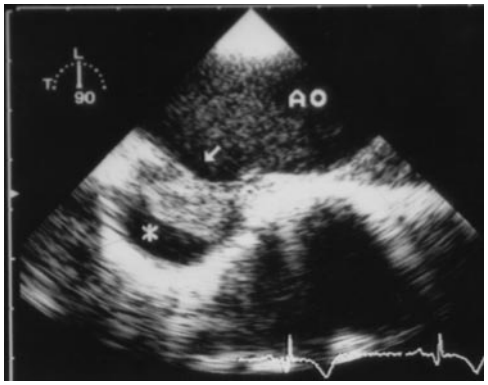


Figure 3. Patient 3. TEE scan in the longitudinal plane (L). A pseudoaneurysm **(asterisk)** with partial thrombosis **(arrow)** can be observed. AO = aorta; T = transverse.

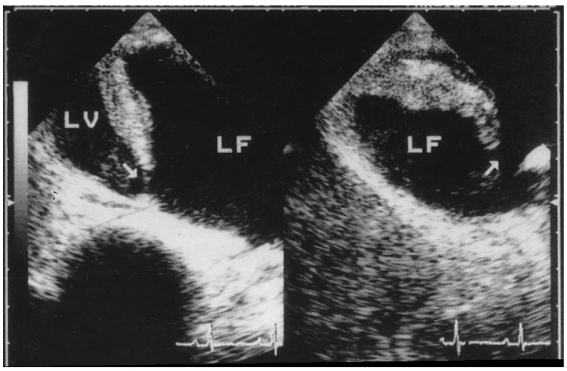
Results

Echocardiography. The lumen surface of the aorta appeared smooth in two patients (Patients 5 and 11). Protruding fibrotic or calcified plaques and severe, complex atherosclerotic changes of the aortic lumen were detected in the other 10 patients. Aortic ulcers were located in the descending thoracic aorta in eight patients, the aortic arch in two and the ascending aorta in two. TEE could document the presence of penetrating aortic ulcer or its complications in 10 patients but failed to detect this lesion in the other 2 (one with aortic ulcer in the distal ascending aorta [Patient 5] and one with aortic ulcer in the aortic arch [Patient 4]). In four patients, the ulcer was detected as a calcified focal outpouching of the aortic wall and was associated with concomitant aneurysmal dilation of the aorta in two and a small localized intramural hematoma in one (Patient 1) (Fig. 2). TEE visualized a partially thrombosed pseudoaneurysm complicating a penetrating aortic ulcer in the descending thoracic aorta of two patients (Patients 3 and 7) (Fig. 3).

Four patients had an aortic ulcer complicated with a "limited aortic dissection" in the descending aorta that could be detected by TEE (Fig. 4 to 6). This type of localized dissection had the following echocardiographic characteristics: 1) a markedly thick dissection flap (range 0.8 to 1.1 cm), calcified, irregular, shaggy and nonoscillating or of low mobility; 2) limited longitudinal extension (<10 cm) in the descending thoracic aorta away from the origin of the left subclavian artery; and 3) a true lumen similar to or larger than the false lumen.

Follow-up data. Mean follow-up was 11 months (range 1 day to 24 months). All patients were initially treated with antihypertensive medications and supportive measures in the coronary care unit while various diagnostic tests were performed.

Five patients underwent operation, two because of aneurysmal dilation of the aorta (>6 cm), and three because of aortic dissection (one had a rupture of the false lumen wall demonstrated by TEE [Fig. 7]). Two patients died early after hospital admission because of aortic rupture (Patients 4 and 5). The remaining five patients did well without operation.



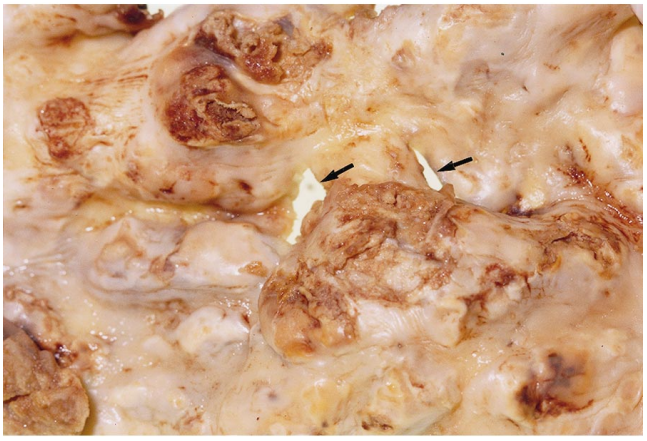


Figure 4. Patient 8. **Top,** TEE scans in the longitudinal plane. A thick, calcified, irregular flap can be seen. **Bottom,** Corresponding anatomical specimen. Dissection flap with multiple aortic ulcers. **Arrows** show entrance and reentrance tears. LF = false lumen; LV = true lumen.

Discussion

In 1986 Stanson et al. (7) described penetrating atherosclerotic aortic ulcers as a distinct clinical and pathologic entity in which plaque erosion and ulceration penetrate the internal elastic lamina into the media. When this penetration occurs, a localized aortic intramural hematoma may develop. In the present report, only one patient had an associated intramural hematoma. However, in one series of 16 patients (8), all 16 had an associated intramural hematoma. In most patients this intramural hematoma is localized, but it occasionally can involve the entire descending thoracic aorta (1). These ulcers may also be complicated by aneurysm and pseudoaneurysm formation, aortic transmural rupture and even aortic dissection (1–9).

Aortography, CT and MRI have emerged as useful techniques in documenting aortic ulceration and its complications (1,8–12). TEE has greatly enhanced our ability to assess patients with suspected aortic disease (4,6,13–17); however, only one case report has described the diagnostic role of TEE in penetrating aortic ulcers (18). To our knowledge, the present study is the first to describe a series of patients with

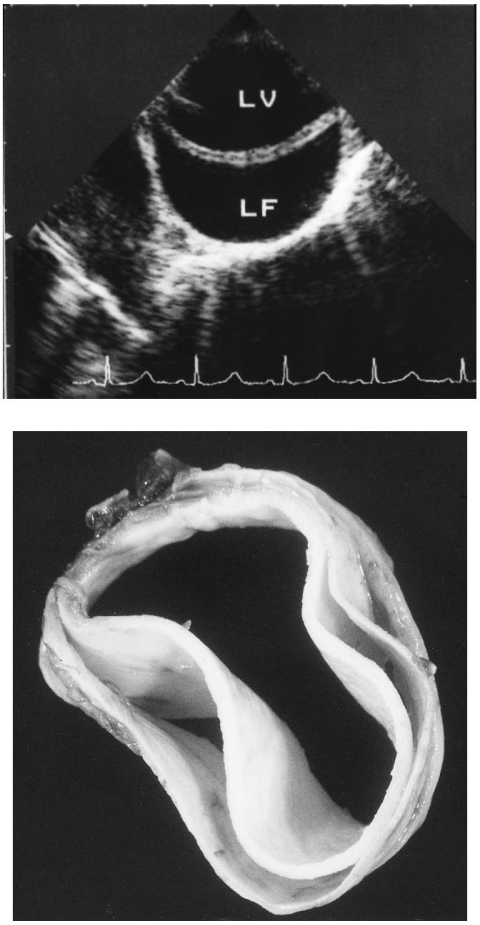


Figure 5. Top, TEE scan in the transverse plane showing a flap from a patient with a classic dissection. Compare with Figure 4, top. **Bottom,** Anatomic specimen of the descending thoracic aorta from a patient with a classic dissection. Compare with Figure 8, bottom. A thin dissection flap can be seen. Abbreviations as in Figure 4.

these lesions for whom echocardiographic imaging findings are available. Typically, the ulcer is visualized as a craterlike or focal outpouching in an atherosclerotic aortic wall in the

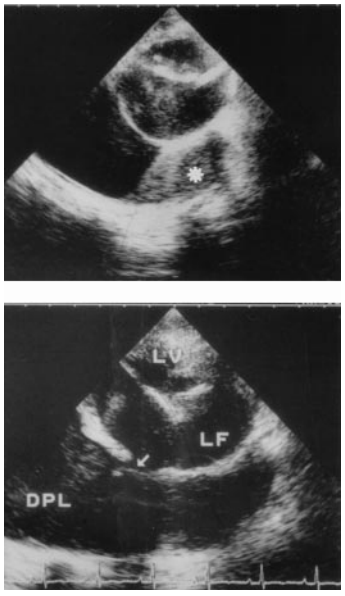


Figure 7. Patient 8. TEE scans in the transverse plane showing aortic dissection. **Top,** A large hemothorax **(asterisk)** can be seen. **Bottom,** Rupture of the false lumen wall **(arrow).** DPL = pleural effusion; other abbreviations as in Figure 4.

middle to distal portions of the descending thoracic aorta (Fig. 1). Initially, TEE may fail to identify the aortic ulcer and may reveal only intramural hematoma from a tiny aortic "ulcer mouth" (18). Two of our patients had transmural aortic rupture (Patients 4 and 5) very early after hospital admission; in one patient, the rupture was located at the distal ascending aorta and was missed by TEE. This oversight may have been a result of the small size of the rupture, observer inexperience in recognizing this entity on TEE or the location of the rupture—the distal part of the ascending aorta—a "blind region" for TEE. From available reports (8,11), free transmural rupture seems to be uncommon. More frequent in the natural history of penetrating atherosclerotic ulcers is the propensity to aneurysm and pseudoaneurysm formation (7,11,19) (Fig. 8). In the

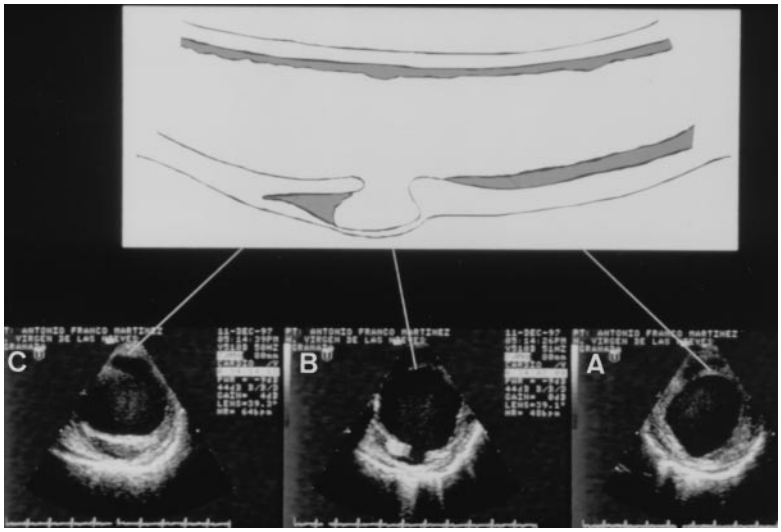


Figure 6. Patient 12. Schematic drawing of a longitudinal section of the aorta and TEE scans in the transverse plane showing a dissection flap secondary to an aortic ulcer. **A,** Mural thrombus; **B,** aortic ulcer; **C,** localized aortic dissection.

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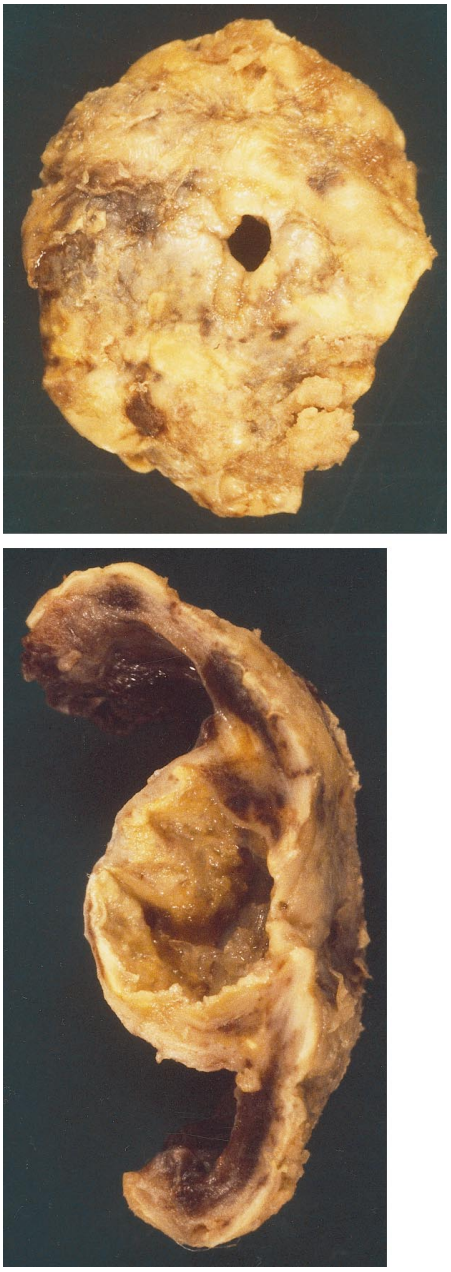

Figure 8. Anatomic specimens from Patient 8. **Top,** Penetrating atherosclerotic aortic ulcer in the descending thoracic aorta. **Bottom,** Sagittal section.

present study, TEE visualized a partially thrombosed pseudoaneurysm in two patients; in two other patients, the aortic ulcers were associated with concomitant aneurysmal dilation of the aorta.

Close follow-up is probably advisable for all penetrating aortic ulcers, even those found incidentally (11). TEE can play a major role in the diagnosis and follow-up of these lesions. It is too often deduced that aortic dissection is due to intimal disruption and that subsequent death needs no other explanation. There are of course some common findings in all dissections, such as the division of the aortic media, but little attention has been directed at the myriad of other events and particularities influencing the final morphologic picture and the clinical course. In the present study, we described the characteristic TEE findings that should suggest aortic ulceration as the origin of the dissection: a thick, calcified, irregular and nonoscillating flap; localized dissection, and a large true lumen. Progression of a penetrating aortic ulcer with intramedial hematoma (segmentary aortic wall dissection) to classic aortic dissection with an intimomedial flap and a double aortic lumen has been rarely documented (9). One of our patients (Patient 12, Fig. 6) is the paradigm of this possibility.

Other reports support the concept of aortic dissection secondary to an atherosclerotic ulceration. In 1941, Willius and Cragg (20) described that some of their cases with aortic dissection and an entrance tear in the distal descending aorta were associated with "ulcerating atheromatous abscesses." Shennan (21) described 4 of 218 cases of aortic dissection in which the dissection began in the base of an aortic ulcer. Gore and Hirst (22) reported that aortic ulcers are occasionally a cause of aortic dissection (<4%). Conceivably, recognition of these ulcers by TEE may permit earlier diagnosis of aortic dissection and the institution of appropriate treatment.

Clinical implications. Discriminating between prenetrating aortic ulcer, aortic intramural hematoma and classical aortic dissection can be difficult. All are part of what may be called "acute aortic syndrome" and in some patients, the physiopathologic basis of these entities is probably not very different. At the initial examination some echocardiographic clues will help to differentiate aortic ulcers from the aforementioned aortic lesions. Classical aortic dissection frequently exhibits the presence of a mobile linear echo indicative of a dissection flap and an entrance tear. The echocardiographic diagnosis of an aortic intramural hematoma relies on the detection of localized increased aortic wall thickness (>5 mm). This segmental thickening of the aortic wall can be circular or crescent shaped and, in general, has a thrombuslike appearance (13). By definition, there is no intimomedial tear and, therefore, the presence of blood flow within the intramural hematoma is an infrequent finding (13). The echocardiographic appearance of a penetrating aortic ulcer is commonly depicted by a craterlike or focal outpouching in an atherosclerotic aortic wall.

Conclusions. Most of our patients were hypertensive and had chest or back pain on admission. In nine patients, the initial working diagnosis was acute aortic dissection. Therefore, penetrating atherosclerotic ulcers of the aorta should be included in the differential diagnosis of acute chest or back pain, especially in elderly hypertensive patients. These ulcers and their complications may be recognized by TEE.

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